

16 December 1996
ENGLISH ONLY

SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE
Fifth session
Bonn, 25-28 February 1997
Item 7 of the provisional agenda

TECHNOLOGY AND TECHNOLOGY INFORMATION NEEDS

Comments from a Party

Note by the secretariat

By its decision 7/CP.2 (FCCC/CP/1996/15/Add.1), the Conference of the Parties, at its second session, requested the Convention secretariat to give high priority to the development and completion of a survey of the initial technology needs, as well as technology information needs, of Parties not included in Annex I to the Convention, with a view to providing a progress report to the Subsidiary Body for Scientific and Technological Advice at its fourth session. The COP also urged non-Annex I Parties to communicate initial information to the Convention secretariat not later than 1 December 1996 regarding technologies and know-how required to address climate change and its adverse effects that could be compiled by the secretariat into a detailed list of technology needs required by developing country Parties, taking into account that more elaborate technology needs would be included in their initial national communications.

In regard to the latter request, the secretariat has received a submission from China. In accordance with the procedure for miscellaneous documents, this submission is attached and reproduced in the languages in which it was received without formal editing. Any further submissions from Parties will be issued in an addendum to the present document.

In regard to the first request, the secretariat has initiated a survey of the technology needs of 20 Parties not included in Annex I, to obtain preliminary information and to test a survey instrument. The secretariat will provide information on the results of this survey at the fifth session of the SBSTA.

FCCC/SBSTA/1997/MISC.1
GE.96-64745

**Department of Treaties and Law, Ministry of Foreign
Affairs**

225 Chaonei Street, Beijing 100701 Tel (8610) 6525 5520 Fax (8610) 6513 4505

14 November 1996

Mr. Michael Zammit Cutajar
Executive Secretary
Climate Change Secretariat
PO BOX 260124
D-53753
Bonn
Germany

Dear Mr. Cutajar,

I have the honour to communicate to you the initial information regarding technologies and know-how required to address climate change and its adverse effects, in accordance with the decision taken at COP2 on development and transfer of technologies. Please find enclosed a List of Technologies for that purpose.

With regards.

Yours sincerely,

CHEN SHIQIU
Director General

LIST OF TECHNOLOGIES

1. Integrated Gasification Combined Cycle (IGCC)
2. Direct Reduction
3. CFB Coal Gasification for Ammonia Synthesis
4. Vapour Emission Control Systems
5. Biomass Gasification & Purification
6. Fuel Forest-Fired Power Generation in South China
7. Fuel Cells
8. Smelting Reduction
9. Poultry/Livestock Wastes for the Production of Organic Compound Fertilizer--Complete Technology
10. No-tillage for Man-made Forest in South China
11. Forest Ecosystem Management Systems
12. Waste Land Afforestation for Mine Area
13. Solar Hot Water Heater--Vacuum Tube
14. Rice Husk Energy Transfer Instrument
15. Pony-tail Pine Protection in Acid Rain Area

1. Integrated Gasification Combined Cycle

1.1. Technology Name

Integrated Gasification Combined Cycle

1.2. General Characteristics

Integrated Gasification Combined Cycle (IGCC) is an advanced power generation technology. The fundamental of IGCC is uses the cleaning gas produced from gasification and purification as fuel for the turbine, combines the gas turbine with steam turbine. It consists of coal pre-process, coal gasification, gas cleaning, and combined cycle power generation. The main advantages of IGCC are as follows: First, it offers high thermal efficiency, reached from 40 percent to 50 percent is 10 percent higher than of pulverized-coal (PC) fired power generation. The unit coal consumption is 310 gce/kWh. Second, it is relative insensitive to feedstock, allowing all types of coal to be fired. Third, it has a good commercial market.

1.3. Cost Information

The capital cost of early IGCC technology for the Cool Mater plant is much higher, and reached \$2,538 /kW. Now for the commercial IGCC plants (500 Mw), the capital cost is approximately \$900 /kW. The operating and maintenance cost for this plant amount to about 4 to 4.5 cents/kWh, which design lifetime expected 20 years.

1.4. Environmental Effects

The IGCC plant has low emissions of pollutants, and good environmental characteristics. Its desulphurization efficiency reached from 90 percent to 99 percent used a cleaning measure, and SO₂, NO_x and particulate emissions had been controlled. It reduces the formation of NO_x to levels from 25 percent to 60 percent lower than that from a conventional PC plant, as the same of burning natural gas. Increased thermal efficiencies result in lower carbon dioxide emissions per unit electric generation, is about 0.8 kg/kWh.

1.5. Market Potential

With the development of society and economy of China, the present thermal power capacity will need to be expanded further. ICC is an advanced power generation system that combines a higher coal-electricity production of efficiency with clean coal combustion technology. It is anticipated that IGCC technologies have the capacity to

replace the steam turbine in the fossil-fired power plant, as a key development direction in this field.

China fully recognizes the problems of sustainable development and pays much attention to the retrofitting of aged power plants by introducing advanced technologies and new models of power generation. China has already imported more than ten sets of oil-fired or gas-fired combined cycle units. In addition, China's Ministry of Electric Power has emphasized the power generation technology of IGCC by placing it on the agenda of its plan for middle-term and long-term development of electric power. So, it can serve as the foundation for a large-scale application and diffusing of IGCC technology in China by introducing advanced technology of ICC and constructing a demonstration power plant.

1.6. Other Information

- For the form of introducing, it is suggested to combine cooperative research (such as on new thermal cycle and system integrity of system) with technology imports (such as gasification, hot dry cleaning, and advanced gas turbine).
- Based on the technical cooperation and imports, it is proposed to construct a 200 Mwe IGCC demonstration power plant with good values for spreading by using the GEF grants and loans of low interest from financial organizations.

2. Direct Reduction

2.1. Technology Name

Direct reduction

2.2. General Characteristics

The direct reduction technique of producing sponge iron is one of iron-smelting processes, which uses gas or liquid fuel and non-coking coal as energy and reducer, reduces metal iron at the temperature condition that iron ore (or include iron pellet) is solid. Considering the different reducer used, the direct reduction technique can be generally classified into two sub categories: gas-based process and coal-based process. Based on the difference reductive device, it can be divided into vertical furnace process reaction pot process, fluidized-bed process, and rotary kiln process, etc. The output around the world in 1994 was 28.2 million tons and the average utilization rate of the device was 73 percent. The widest processes used in industry now are Midrex and HYL in gas-based process, as well as SL/RN and DAVY's DRC in coal-based process. It was reported that the process used in DAVY's Direct Reduction Plant was rotary kiln, which reduce directly using coal-based as reducer. The metallization rate was 93 percent, iron rate was 96 percent, per ton direct reduction iron consumed 0.425 ton solid carbon, and 90-120 kWh electricity (of which 65 percent in direct reduction plant, 26 percent in material plant, 9 percent was auxiliary consumption).

2.3. Cost Information

The first direct reduction iron plant, named Kazuo County's Sponge Iron Smelting Plant in Liaoning province of China, invested 52.92 million yuan, the capacity was 25,000 tons, the average 10000 tons capacity investment was 2117 yuan, this number is \$122.87 in Venezuela and \$161.20 in Europe.

2.4. Environmental Effects

The energy consumption of the direct reduction technique is low, which is only from 40 percent to 50 percent of that of iron-melting in blast furnace, so it can reduce from 50 to 60 percent CO₂ emissions per ton steel.

2.5. Market Potential

The output of electric steel only occupies 22 percent of the whole steel output in China, while this share in developed country has reached from 30 percent to 40 percent, 56 percent in Italy. With the increase of steel accumulating in China the retrieve amount of scrap steel will be going up, and electricity is relatively plenty, so the short process used scrap steel as material will develop rapidly, therefore, the requirement of sponge iron with little impurity will grow rapidly.

2.6. Other Information

- To introduce the technique of coal based as reducer is more conformable with the actual situation in China with an abundant coal and a limited nature gas resource. The contents of technique introduced include process technique, production software, key parts in the main device, and automatic control unit in instruments and meters.
- The main problem in introducing the line of sponge iron production is funds. It is necessary for China to obtain the help from GEF, to gain donation accounting for more than 1/3 of the total funds for projects, and loan with lower interest rate. After the projects being founded, China's Ministry of Metallurgical Industry will bring it into line with the country's overall plan, and help the enterprises to put into effect the funds and equipment's domestic.
- China's Ministry of Metallurgical Industry will be in charge of introducing affairs, and put them into practice in Xining Steel Plant and other plants.

3. CFB Coal Gasification for Ammonia Synthesis

3.1. Technology Name

CEB Coal Gasification for Ammonia Synthesis

3.2. General Characteristics

The technology of CFB coal gasification is a new process under R&D to convert a wide variety of solid fuels--biomass, coal, wastes into crude gas for fuel, town, and synthesis gas production in recent years. This technology is very suitable for replacing the old low efficiency UGI gasification process in small size ammonia plants which gasifier capacity limit is around 150 Mwth. The first commercial scale plant based on CFB gasification (27 Mwth) which produced low-Btu gas from bark was put into operation in Austria in 1986, and the gas is used in a paper mill for lime calcimining. Up to now, there is no commercial plant for ammonia synthesis that has been in operation.

3.3. Cost Information

The CFB gasifier is operated at pressure less than 0.15 Mpa (called "quasi-atmospheric"). This pressure level allows continuous fuel feeding and ashes removing by using rotary feeders, obviating the necessity for lock hopper systems like with most pressure gasification temperature. Since both CFB and UGI gasifier are operated at the same pressure level, the existing UGI gasification plant can be replaced by CFB that need introduce N₂ to system prior to compression to keep the almost same content in the crude gas generated from CFB and UGI. So, it only needs to construct a CFB gasifier which corresponds to about 100,000 TPY of NH₃ capacity, without the necessity to renew the whole existing down stream compression and purification units. It also can reduce a lot of investment and the operation cost obviously.

3.4. Environmental Effects

It is the appropriate range of capacity for one atmospheric CFB gasifier (500 TPD of coal feed) which corresponds to about 100,000 TPY of NH₃ capacity. It uses 20.8 tons of coal to produce 13.89 tons of in one hour, and the average coal consumption for per ton of NH₃ is 1.497. It accounts for 64 percent of the total output of ammonia synthesis in China which used coal by UGI gasifier. This process emits about 4000 m³ of purge gas for per ton of NH₃ which the CO₂ content is 12 percent, that is 1.0 tons. If we use CFB gasifier to replace UGI gasifier to generate urea or ammonium bicarbonate, it is zero emissions under normal conditions, and the carbon content of ash is lower than 5 percent. So, if the 50 percent of UGI gasifier were replaced by CFB gasifier, it will reduce 7.8 Mt of CO₂ emissions.

3.5. Market Potential

In China, the output which produced from the middle and small size ammonia plants amounts to 80 percent of the total output of nitrogenous fertilizer, among which, about 80 percent of the total capacity need to be fed with coal. These plants were almost use anthracite coal to generate gas by the conventional UGI gasifiers. The production of anthracite coal is relative concentration, but the ammonia plants is distributed around country. This not only result in a long distance transport of coal but also affects the utilization ratio of ammonia plant capacity by limited resources. Meanwhile, the UGI gasifier is disadvantageous for its low efficiency, low carbon conversion rate, and difficulty with pollution control. For all these aspects, it is very necessary for China ammonia industry to seek a gasification process which both improved environment and used local coal resources, this issue also is a common problem. So, the CFB coal gasification for ammonia synthesis has good values for spreading.

3.6. Other Information

- At present, the CFB coal gasification which generated fuel and town gas has reached industrialization, but no one can be used for ammonia synthesis. So, it needs to do more detailed work, though the Lurgi had operated in its Research and Development Center.
- It is suggested that introduce this technology from Lurgi company by the Ministry of Chemical Industry of China, and which will be applied in the Xuanhua Ammonia Plant in Hebei province.

4. Vapour Emission Control Systems

4.1. Technology Name

Vapour Emission Control Systems

4.2. General Characteristics

Vapour Emission Control Systems are designed to collect vapours of flammable cargoes from tanker cargo tanks, and process vapours on board or at shoreside terminal during cargo loading and unloading operations, in order to reduce the flammable vapours emit to the atmosphere, promote the operation safety, and protect the environment pollution. It includes the vapour collection system and the vapour processing unit. The vapour collection system consists of closed gauging device, liquid overflow protection system, vapour overpressure and vacuum protection system, and vapour line connection system. The vapour processing unit means the components of a vapour control system that recovers, destroys, or disperses vapour collected from a tanker, at present, this system uses many different technologies, such as carbon bed absorption and lean oil absorption.

4.3. Cost information

In order to coordinate the issues of interest to each other on "safety transportation and environment protection" in ocean shipping, International Maritime Organization (IMO) draw up a convention (MARPOL 73/78) on preventing ocean pollution from shipping, China is a signed country. According to the management regulation under port'country recommended by IMO, it is the duty for the port administration to allow ship leave, until the ship is in accord with the demands. Before the implementation of the annex 6 of the convention, some developed country has already carried out similar regulation, such as USA, in the chapter one of the 46 CFR, published in October 1, 1990, had provided a clear definition on the vapour emission control systems. So this technology not only concerns the reduction of the amount of ocean shipping and environment pollution, but also relate the problem whether China's ship can enter other country's port and other country's ship will be allow making port in China or not. At the moment, this system is expensive in the international market.

4.4. Environmental Effects

In China, about 1/3 of the freight volume of the petroleum is used international trade, and resulting in a worldwide environment pollution. If we use the vapour emission control systems, it will operate in the closed condition for cargo loading or unloading, and meet emission standards, even realize zero emission. It also will recover the vapour, save energy, and reduce the loss of cargo. Meanwhile, besides cover the shipping transport need, this system is efficient reliable and safety, which will be manufactured and spread domestically, and can also been used in land area based on introducing technology.

4.5. Market Potential

The characteristics of the shipping equipment have to be consistent with international standards, these devices have to accord the demands for the shoreside facilities at port of the other country, also, these devices should meet the requirements of standards of international convention. It's the same the other way round. So, for the equipment located both onboard and shoreside terminal need to be approved by the local administrations based on the regulation recommended by the international organization. At present, these are not user for vapour emission control systems in China, and its market potential also is very large. It's the best way for China to meet this issues by introducing the commercial technology.

4.6. Other Information

- It is suggested that adopt technology license to introduce the commercial techniques and process, and manufacture key equipment domestically, supported by the GEF grants.
- It is suggested that this technology will be responsible for technology introducing by the Ministry of Communications of China, and which will be carried out by the Shanghai Ship & Shipping Research Institute.

5. Biomass Gasification & Purification

5.1. Technology Name

Biomass Gasification & Purification

5.2. General Characteristics

Biomass gasification technology is a method of converting woods, stalks and some other solid biomass fuels which are not appropriated for direct use into convenient gas fuels used for cooking, generating, as well as for some industrial purpose after cleaning. It includes air gasification, oxygen gasification, thermolysis, steam gasification, etc. The key technology of process is biomass gasification equipment and fuel-purification equipment. By statistics in 1993, there were 343 biomass gasification thermal-power plants in the world, and the countries holding the leading technology in this field are Sweden, USA, etc. Canada also put some products of biomass gasification furnace in different specification into market. Which use wood-dusk and paper or not waste as a fuel, and produce coal gas to drive internal combustion engine in advanced countries have reached from 60 percent to 90 percent, the caloric values of fuel gases are ranged from $1.7 - 2.5 \times 10^4 \text{ KJ/m}^3$.

5.3. Cost Information

The current biomass gasification equipment developed by the advanced countries are general large scale with high automation and complex technical process, merely for power generation and heating supply, the costs are rather higher. The utilization of biomass gasification in China are mainly on drying or space heating and power system, the biomass gasification equipment used for power generation have two kinds, they are grain husks coal and oil gas double fuels generator units which is suitable for enterprise's small-scale power generation and the per investment of power station are both reduced about 30 percent.

5.4. Environmental Effects

Because of biomass resource's renewable property, large quantities and high efficient utilization can bring about an obvious benefit of environment and ecosystem. Gasification one ton of biomass fuel can reduce 1.3-1.5 tons of CO₂ emission and is equivalent to 0.5 tce of fossil energy resource.

5.5 Market Potential

At present, China's biomass gasification equipment R&D is still on the original stage, the level of gasification technology research is relatively lower, especially on the aspects of increasing fuel gas caloric value and its cleaning degree, we still have some technical barrier. It is prospected that the demand for high quality cleaning gasification energy will increase, as China countryside overall economic growth, the biomass gasification, being a way of energy end-use, will become one of the main issues for rural energy development and utilization. Its market has big potential. The key demand markets are as follows: (1) Forest areas with rich and concentrated biomass resource. In terms of country's total wood output of 60 Mm³ the waste will be above 25 Mm³. (2) Farm area with abundant and high quality grain crops stalks. It is calculated that the annual yield of grain crops stalks in China has exceeded 600 Mt which is equivalent to 300 Mtce of energy. (3) Agriculture and forest products processing industries with energy short. Each year China has wood waste of wood processing industries about 20 Mm³ and grain crops husks waste about 50 million tons. (4) No-coal or short coal prairie and mountain areas.

5.6. Other Information

- Selecting appropriate gasification equipment and cleaning technology suited to characters and tech-economic level of China's rural areas. The introduced equipment scale should be small or middle size with gasification furnace diameter under 1000 mm and gas output of 200 m³. Adopting the forms of cooperation development or trade license introduced technology, organizing equipment production and demonstration spread domestically.
- The Ministry of Agriculture will be charge of technology introducing, this project will be coordinated the implementation by Institute of Energy under Shandong Academy of Science.

6. Fuel Forest-Fired Power Generation in South China

6.1. Technology Name

Fuel Forest-Fired Power Generation in South China

6.2. General Characteristics

As an alternative energy, fuel forest-fired power generation in south China is a conversion process from biomass energy to electricity power. Biomass energy power generation has several systems, such as direct combustion of biomass, combined combustion and DFSS. The current prevalent biomass power generation technology use condensing turbine, another choice is gas turbine, its coal gas fuels are produced by biomass thermal-chemical gasification. The most possible biomass power generation technology can be BIG/GTS which will probably become a commercial power generation in this century. Fuel forest-fired power generation is belong to specific feedstock supply system, it's also no technical problems existed. There have been some experimental examples in Indonesia and Guatemalan.

6.3. Cost Information

Although we have some examples of fuel forest-fired power generation, the economical benefit problem still remains unsolved. The solid biomass fuels have relatively higher ratio of~ input and output transportation cost and power cost. So, the urgent need is in order to develop an experimental research, reduce power cost and make this technology have both environment and economical benefit.

6.4. Environmental Effects

The CO₂ emission reduction by using fuel forest-fired power generation determined by how much firewood used. It depends on the power station scale. Taking an example of small network severed by five sub-regions. Supposing each sub-region has 500 ha, the annual biomass output would be 40m³ (about 18 tons carbon), the carbon emission would reduce 22500 tons per year. The amount of CO₂ emission caused by burning firewood also can be offset by CO₂ absorption during firewood growing, so, the fuel-fired power generation will not increase CO₂ emission. Meanwhile, woods usually do not contain sulfur element. It also can have some impact on atmospheric SO₂ emission and acid rain controlling.

6.5. Market Potential

The operation purpose of firewood plantation is to produce biomass fuel, among the energy forest operated by the means of short rotation, the firewood plantation prn good features of rapid profit. high output, good adaptability, low cost, etc. The South of China shares a warm climate with abundant rain and forest resources, so the firewood plantation by utilizing local fast-growing tree feeds would achieve a short production period and a lager yield. It's really an expected way to reduce carbon emission by using fuel forest-fired power generation. As the increasing realization of environment issues, more and more people would like to accept biomass energy. Therefore, the market for this technology will be promising.

6.6. Other Information

- Expecting get some hinds from GEE for the technology introducing. In order to reduce transportation expenses, the small power station should be built beside mountains in the scale of sub-region unit, and connecting several these small power station forming a regional network.
- The Ministry of Forest will take responsibility for technology introducing, this project will be coordinated the implementation by both Tropical Forest Research Institute, Ministry of Forest and Guangdong Forest Bureau.

7. Fuel Cells

7.1. Technology Name

Fuel Cells

7.2. General Characteristics

Fuel cell is a device which can transfer chemical energy of the fuel into electric energy. Its main body is composed of two different kinds of polar materials and the matching electrolyte. When fuel and burning-rate accelerator are piped into two poles separately by an aiding device, chemical reaction will occur in the electrolyte under the affections of both polar materials and electrolyte (including catalyst sometimes), and then power energy will directly be generated. The efficiency of power-generating of fuel cells can be from 40 percent to 60 percent, which is two times of that of thermal power generation. Total efficiency can reach 80 percent, for the heat blown off can also be used. Fuel cell can use a great number of kinds of fuel, and the scale and application of the cell can be chosen. Now there are some advanced fuel cells in some countries, for example, the fuel cells invented in Australia is the third generation of ceramic polar fuel cells, and phosphoric acid type fuel cells made in America used phosphoric acid as the electrolyte. In Japan the fuel cells with 11,000 kW have been working smoothly, and the total installment capacity of the cells has reached 18,000 kW. Japan also invented metal fuel cells which can generate electricity only at 80 C or so. It is reported recently that Sanyo Electric Corp. Limited had developed portable fuel cells using compressed hydrogen, whose power has been about 100 kW. It can be predicated that this technique will be commercialized and become dominating technique in this filed in 1996.

7.3. Cost Information

From the view of the investment of capital construction, it is reported that the cost for advanced large device is about \$600 per kW, if added with waste disposal cost, it would reach \$1400 per kW. The investment to the small power plants whose technique is not advanced will be higher. Under current conditions, the producing cost of fuel cells is much higher - about \$2500 per kW due to the complicated techniques, and the capacity is 20,000 kW. Nevertheless, when the capacity can reach 20,000 to 30,000 kW, this technique will be economical. For the operation cost, comprehensive circulation cost of combustion turbine is \$0.077 per kWh, the cost of coal-burning power generation is \$0,083 per kWh, and the cost of fuel cells is 0,073\$ per kWh. From the view of the cost of electricity transmission and distribution, the cost of electricity transmission and distribution in developed countries is \$500 per kW. While in developing countries, power consumer is more scattered, and the cost is more high. However, fuel cells can save this cost, for they do not need electricity transmission and distribution.

7.4. Environmental Effects

Fuel cells almost neither produce greenhouse gases such as CO₂ which can cause the global warming nor blow off SO_x or NO_x. They are clean energy resources, polluting environment very little, and not like power plants which will consume great lands. Present examples indicate that using fuel cells can reduce the emission of CO₂ at 40 percent to 60 percent, SO_x and NO_x at about 90 percent.

7.5. Market Potential

Because of the wide range of application, fuel cells have very large market capacity. Now they can be applied in some special fields. When being economical, they can be applied in extensive circumstances.

7.6. Other Information

- It is suggested that the way of "Starting from Application, Developed by Projects" should be adopted. First, it is necessary to introduce fuel cells consuming common energy resources and set tip typical examples according to the need, and then to introduce fuel cells matching with biomass gasification unit and to develop apartment or district type co-generation by biomass energy.
- The Ministry of Electric Power and the Ministry of Agriculture are planed to take charge of the work of introducing and implementing the technique.

8. Smelting Reduction

8.1. Technology Name

Smelting reduction

8.2. General Characteristics

The smelting reduction technique of producing molten iron is one of direct iron-smelting process, which use pulverized coal and oxygen, reduce with ore powder in the condition of high temperature and liquid state, and make most of the reactions happened in the liquid oxidize phases. Smelting reduction will be the new technique of iron and steel smelting in the 21 century. The first time to do technique experiment was in steel ladle in West Germany in 1977, South Africa imported a set of smelting reduction technique and device (Corex device) from Austria Iron & Steel Union in 1985, which can produce 0.3 million ton molten iron per year and put it into production in the end of 1989, producing 0.34 million ton molten iron per year, per ton iron average consumed 640 cubic meters oxygen, coal 1183 kg, and meanwhile, produced lots of high calorific value gas as by-product, the compositions of the molten iron and its temperature are almost Same as that of the production from the blast furnace. Puxiang Iron and Steel Plant in South Korea has constructed a set Corex device which can produce 0.6 million tons molten iron per year. At present, the following process would become the process in a scale of production: Japan's DIOS process. Australia's HIS melt process, Russia's ROMELT process, Germany's Lurgi process and America's AISI process. etc.

8.3. Cost Information

Smelting reduction technique cuts down the coke oven and sintering workshops, so its construction cost is less about 20 percent to 30 percent than that of blast furnace process. It can reduce a lot of employees, therefore, lessen the operation cost; the processes can reduce energy consumption, the cost of the products will be down, the cost is about 10 percent to 20 percent lower than that of the blast furnace process.

8.4. Environmental Effects

The smelting reduction technique of producing molten iron can cut down environment pollution, it can obviously reduce the emission amount of poisonous gas, such as dust, SO₂ and NO_x. 40 percent of dust emission in steel production can be reduced because of omitting sintering and coking process, especially, the investment of controlling pollution in a ton steel production dropped over 25 percent because of reducing pollution from polycyclic aromatic hydrocarbon in the coking. Meanwhile, because of omitting energy consumption in sintering and coking process, 35 percent of energy consumption amount for per ton steel can be saved, and about 25 percent of CO₂ emission amount per ton steel can be reduced.

8.5. Market Potential

China is a developing country, the steel output in 1994 reached more than 91 million tons, but the average steel output possessed by per capita was only 60% of that of the world. It's predicted that the steel output in 2000 in China will reach 100 million, there

is still a gap of 20 million ton steel. Due to the process technique falls behind the developed countries, the production structure is not reasonable, all of these make material consumption high and environment pollution serious, the quantity and quality of the products could not satisfy demand of the national economic development, therefore, we should adopt new techniques to improve old enterprises so that they can improve both quantity and quality of products, and make the consumption of energy and raw materials lower, protect and improve the environment. It is one of important factors of restricting China's iron and steel industry that the coke resource is limited so iron-melting using non-coke will be useful to the development of iron and steel industry. So, smelting reduction technique has a vast vista in China.

8.6. Other Information

- It is necessary for China to get funds assistance from GEE to introduce smelting reduction technique.
- According to the level of the technique and economy, Corex process is more ripe in smelting reduction technique, China needs to import Corex's whole set of technique and device.
- The Ministry of Metallurgical Industry of China will be in charge of the introducing affairs.

9. Poultry/Livestock Wastes for the Production of Organic Compound Fertilizer--Complete Technology

9.1. Technology Name

Family Animal wastes Produce Organic Compound Fertilizer

9.2. General Characteristics

This technique is to separate liquid from solid wastes, ferment the separated liquid through anaerobic and aerobic procedures, and then drain when accomplished the national standard. While the separated solid wastes will be fermented again, added dregs of the fermented biogas and supplementary ingredients, and then parched to organic compound fertilizer for sale. Now this technique in Japan, Russia and Taiwan is relatively mature, each has its own advantage, through research and technical and economical comparison, the technique and equipment in Taiwan are more suitable for China's situation.

9.3. Cost Information

The best way to resolve the wastes in the large and middle scale animal farm is comprehensive utilization, only this way can reduce the environment pollution greatly and overcome the poor economic benefit. Organic compound fertilizer is very suitable for fruit, vegetable and greenhouse plant, it not only can promote the growth of plant, but also can improve the products quality, its price is lower than chemical fertilizer but its effect is better. As calculated, the dynamic return period of such technique in large-scale animal farm is about 4 years, the investment interest rate is above 30 percent.

9.4. Environmental Effects

This technique converted wastes into fertilizer, changed the pollution source into usable resources, conserved energy, improved environment. It not only resolved the water and air pollution, but also produced high-quality organic compound fertilizer from solid wastes, formed a healthy cycle of the whole eco-agriculture. Biogas is a kind of high-quality energy, can be used directly in life and manufacture when cleaned. With the application of this technique and building biogas engineering, it will further alleviate the condition of lack of energy in rural areas, and effectively protect the plant and decrease woods damage, it is significant to improve local climate and decrease the emissions of harmful gases.

9.5. Market Potential

Now the disposition of wastes of China's large and middle scale animal farm has not been resolved completely, the research on the double fermentation technique is not mature, has not formed a series of usable equipment and technique. So this technique's market capacity is very large, almost all the animal farm can use this technique. According to statistics, the excreta of chicken and pig produced per year will be 581 million tons, together with other excreta, the total will be 700 million tons, mostly indisposed, only a small part disposed with biogas engineering.

9.6. Other Information

- Plan to build a demonstration project in large scale pig farm in Beijing rural areas with the money presented by GEE, import all the assembly line, including equipment and technique.
- The Ministry of Agriculture is responsible for the import, organized by the Institute of Planning and Design of the Ministry of Agriculture.

10. No-tillage for Man-made Forest in South China

10.1. Technology Name

No-tillage for Man-made Forest in South China

10.2. General Characteristics

No-tillage for Man-made Forest in South China, i.e., do not clear the woods when logged, leave the stumps and branches in the woods, plant the saplings in the space between the stumps, convert the conventional method which burn hill, till land, and plant forest to no-tillage and no-burning method, in order to increase the yield of the land, decrease the carbon loss of the land, promote the absorption of CO₂ in the atmosphere. As reported, logging, tillage and plant cause the carbon loss of about 21 percent average in Europe and America, the range will varied according to the method, the carbon loss ranges from 1 percent to 69 percent, in which the logging-burning-tillage method will cause the greatest loss.

10.3. Cost Information

With the no-tillage method, the land will not be cleared, so it will be inconvenient and more expensive when planting. The weed mowing will increase the cost relatively to the common forest. So, the cost of no-tillage will be higher than common forest planting method. While the earlier productivity level may be lower than the common forest, but the later growth and overall yield will surpass the common forest, so the gross economic benefit is that the income will be much larger than the cost invested.

10.4. Environmental Effects

No-tillage method will decrease greatly the soil erosion and the organic substances lost, increase the organic carbon content in land and the land productivity, especially in tropics and subtropics, increase the absorption of CO₂ in the atmosphere, decrease other greenhouse gases emissions, and will benefit to the world environmental improvement. The potential can be showed in three aspects, (1). decrease the loss of organic substances, the quantity can not be calculated by now, (2). obviate the direct emissions caused by burning, (3). increase the forest productivity, increase the absorption of CO₂ in the atmosphere because of the decrease of the land degradation. If the no-tillage method implemented on the 80 percent of fir forest and pony-tail pine forest, and presume that the carbon loss decrease by 20 percent and forest yield increase by 20 percent, the fir forest in South China can increase the absorption of carbon in the atmosphere 200 million tons. such situation can last 30 years, i.e. a forest logging period, so in this period the absorption of carbon in the atmosphere can be increased 75 million tons per year.

10.5. Market Potential

The fir forest and pony-tail pine in China are a quarter of the whole forest area, the fir forest is 9 million hectares, the pony-tail pine is 14 million hectares, presently all these forest zones carry out the burning -tillage- plant method. Because South China is full of rainfall, and the forest zones are located mostly in steep slopes, this kind of operation will cause nutrients and carbon lost, land productivity constantly decreased. So in the South China artificial forest, in order to increase the organic substances content and decrease land degradation, to implement the no-tillage method is very necessary. And China is a country lacking wood, so the market of this technique is very large.

10.6. Other Information

- Advise importing this technique from the USA, the expenditure expected to get from GEE.
- The Ministry of Forestry is responsible for the import, organized by the Forest Eco-environment Institute of the Ministry of Forestry.

11. Forest Ecosystem Management Systems

11.1. Technology Name

Forest Ecosystem Management Systems

11.2. General Characteristics

By utilizing modern information systems and implementing modern management to forest ecosystem, the forest yield can be increased and resources dissipation can be decreased and the absorption of CO₂ in the atmosphere can be promoted. Forest Ecosystem Management Systems is a new technique, meanwhile a relatively difficult technique. In order to increase forest yield and ability to absorb CO₂, the radical approach is to increase the ecosystem management. Now, the yield of intensively managed artificial forest is larger than that of natural forest by several times or even several tenfold. But some intensively managed artificial forest has the problem of land degradation, giving rise to the soil erosion and organic substances loss. To promote the yield of forest generously and depress the land degradation, modern Forest Ecosystem Management Systems must be adopted.

11.3. Cost Information

This project is by implementing modern management to forest ecosystem, to increase the forest yield, decrease resource dissipation. So the investment will focus on local information center, and comprehensively the amount of investment is small and the profit is high. To implement modern management to forest ecosystem is a key step to realize sustainable utilization of resources, and will create significant effect on long-term stability and productivity of forestry.

11.4. Environmental Effects

To implement modern management to forest will greatly increase forest yield, decrease improper utilization and dissipation of forest resources, protect forest resources, improve ecological environment, promote the absorption of CO₂ in the atmosphere, and benefit to China and world environmental improvement. The effect on production increase is determined by quality of the operation, if by most conservative estimate about wood increase of 30 percent per hectare forest, the increase of the whole country's forest will be 85 million m³, is equivalent to an increase of the absorption of CO₂ about 20 million tons.

11.5. Market Potential

China is a country lacking wood, the wood market is very large, so the market capacity of this technique can be regarded as unlimited.

11.6. Other Information

- Now the Forest Ecosystem Management Systems in Australia are relatively advanced, so the technique can be imported from Australia by technique cooperation method, investing jointly, in order to use this technique as soon as possible.
- The Ministry of Forestry is responsible for the import of the technique, the Eco-environmental Research Institute and Forest Resources Information Institute of the Ministry of Forestry should organize the implementation.

12. Waste Land Afforestation for Mine Area

12.1. Technology Name

Waste Land Afforestation for Mine Area

12.2. General Characteristics

Afforestation on waste land for mine area to recover the land and vegetation can absorb CO₂ in the atmosphere and improve the environment. It has been confirmed by practice that afforestation on waste land for mine area is a very effective way to recover ecological environment. Confronted by the present technology of mining and the low percentage of vegetation (from 4.2 percent to 9.0 percent), the exploitation of waste land in China should be based on afforestation. There are many technical examples to be referred to, for example, in Germany, before reforesting on waste land of lignite coal mine, several ways were adopted to improve the soil microbial activity, in the Former Soviet Union, lime and waste material are scattered on poisonous land of open coal mine area to reduce soil acidity, which has promoted the growth of forest; in New Mexico and Arizona of the USA, planting vegetation by irrigation has been succeeded in waste land of mine area. On afforestation, the techniques of the USA are much more advanced.

12.3. Cost Information

The goals of afforestation on waste land of mine area are to improve ecological environment and to absorb CO₂ in the atmosphere. The project does not intend to gain economic profit, so there is no direct economic beneficial result, but there is indirect environmental benefit, which should be estimated by cost-benefit analysis of the environment.

12.4. Environmental Effects

Afforestation on waste land for mine area can notably improve the condition of ecological environment, which is also beneficial to that in China. Moreover, woods can be formed quickly, so there is no need to renovate the land greatly, and only with a little economic investment, the goal of land renovating can be achieved easily and safely. The woods will stand the soil, clean up the air, prevent water loss and soil erosion and reduce the dust considerably. Another goal of afforestation is to provide timbers and fruits, which has a re-generative function. If all the 14 million hectare land is reforested, 25 million tones carbon will be absorbed each year, providing that the annual growth rate of every hectare forest is 8 cube metre.

12.5. Market Potential

Reforestation is a feasible way to regain and reestablish the ecological environment in waste mine area. There are about 14 million hectares of waste land in China with growing at a speed of 20,000 hectare per year which has not been reforested, it has great potentiality for reforestation. Therefore, China can not only obtain nearly 2.1 billion cube metre timbers, but improve ecological environment in mine area greatly, by importing the advanced reforestation technology from the USA and applying it throughout China.

12.6. Other Information

- It is suggested to import reforestation technology and mechanical equipment from America, Germany, British etc.. Meanwhile, Chinese government will establish research projects of waste land reforestation, including improved varieties of woods, reforestation pattern, intensive management and so on, and will put forward comprehensive practical technology combinations of reforestation fit for different mine area and waste land.
- The technology is planned to be imported by the Ministry of Forestry, and carried out by Eco-environmental Research Institute of the Ministry of Forestry.

13. Solar Hot Water Heater--Vacuum Tube

13.1. Technology Name

Solar Hot Water Heater--Vacuum Tube

13.2. General, Characteristics

Solar hot water heater--vacuum tube is a new type of solar heat collecting device which can transfer solar energy directly into thermal energy. The adoption of vacuum technique can reduce heat loss of the collector greatly, which makes itself to be with a sound thermal behavior even at high working medium temperature or at low environmental temperature. This device has good performances such as anti-freezing, high bearing strength, easy fixing and maintaining and so on. Heat pipe type vacuum tube solar collector is an outstanding one in its family. Because of the adoption of heat pipe technique, the heated working substance does not flow through vacuum tube directly, and has the advantages of small heat capacity and thermal-diode effect. The average efficiency of absorption of heat for vacuum tube solar collector per day is above 50 percent. The collector can be used all the year in northern China, and can provide heat more than 20 percent that of normal plate absorber.

13.3. Cost Information

Solar hot water heater-vacuum tube do not consume energy resources during working, and do not need new investment. It is estimated that only the saving of charges for electricity or gas in three years would be equal to total investment. For a family of three to five members, there is enough water to bath all the year if they have a 1.2 square metre vacuum tube collector. In northern China, even in winter two sunny days can provide enough energy to heat a case of water, so it is no problem for every member to have one or two bathes each week, saving about 400 kilogram coal equivalent.

13.4. Environmental Effects

There is neither pollution to the environment during working, nor emissions of waste gases such as CO₂, SO_x, NO_x etc..

13.5. Market Potential

By now, heat pipe type vacuum tube solar collectors manufactured by Beijing Institute of Solar Energy have been appraised and been in lots producing. In foreign countries, Holland's Philips Co. Limited and British Thermomax Co. Limited both have advanced productions taking use of solar energy. Israel's application of vacuum tube solar energy is very popular, and its technique is very advanced. China has more than 200 million families, but the popularity is no more than 0.5 percent, so there is a huge market capacity of 2 million square metre or so each year.

13.6. Other Information

- It is suggested that the production line or the transferring for key technique should be imported. Water tanks and supporting frames necessarily should be manufactured domestically.
- This technique is planned to be imported by the Ministry of Agriculture, and to be implemented by Institute of Energy of Shandong Academy of Science.

14. Rice Husk Energy Transfer Instrument

14.1. Technology Name

Rice Husk Energy Transfer Instrument

14.2. General Characteristics

Rice husk energy transfer instrument is a furnace which can transfer biomass energy of rice's husk into thermal or power energy. It suits to different scales of rice husk energy converter, and the energy transferred will be used to generate power energy, providing heat or dry materials. When its burning is controlled, clean hot gas flow can be obtained, and the carbon content of rice husk can also be controlled, which are significant to increase burning efficiency and provide rice husk on sale. KC furnace generates power by burning husk, because it can partly make use of (directly controllable) the calorific value of fixed carbon of rice husk, the color is tangerine in furnace, and the temperature is about 1100 C. Chemical incomplete combustion degree is much lower in oxidative environment of the furnace, so combustion efficiency of fuel is much high, and the carbon content of rice husk disposed can be controlled between 10 to 30 percent. The dust of rice husk can be used immediately without drying, for the dust extracted from KC furnace is dry already.

14.3. Cost Information

Rice husk as feed can only be a kind of filler, without much nutritive value. With the development of Chinese grain production, rice husk will not be used as feed, but as a source of fuel, which has important practical significance and social economic benefit. For Chinese rice production area, in the case of lacking fuel and electricity power practically, building relevant rice husk power station, supply center, or drying plant near large or middle rice pearlier factories is a feasible way to comprehensively utilize the resource of rice husk, meanwhile the disposal of the husk can be reduced.

14.4. Environmental Effects

Chinese production of rice is 176 million tones in 1994, about 40 percent of the world's, if converted to rice husk, there would be 34 million tones. Chinese area lacking energy resources (like Zhejiang province), depends on the transported coal, oil and so on from other provinces. Zhejiang province's dominating grain is rice, and most of the rural areas produce rice, so making use of rice husk as power fuel can solve the problem of lacking fuel at a certain degree, especially to those area which is not crossed by railway. Moreover this is an important to protect forest and reduce the energy consumption for transport.

14.5. Market Potential

China's generating sets mostly belong to stacking retort gas power generating, so the calorific value of fixed carbon of rice husk is relatively less used. In furnace, the color is light red, and the temperature is about 500 to 700 C. Chemical incomplete combustion degree is much large in neutral or reduction environment of the furnace, so the carbon content not burned in rice husk disposed is about 40 to 50 percent of the dusk. This technique in America is advanced (American PRM Rice Pearlier Corporation), meanwhile China has many experts having study rice husk combustion technique for some years, who can fully assimilate the technique and develop rice husk combustion furnace suits according to Chinese condition. Thus this technique surly has a wide market capacity and a bright future.

14.6. Other Information

- Expert group should be organized to investigate the situation of manufacturing and applying, and should be imported a typical KC furnace.
- This technique is planed to be introduced by the Ministry of Forestry, and to be implemented by Planing and Designing Institute of the Ministry of Agriculture.

15. Pony-tail Pine Protection in Acid Rain Area

15.1. Technology Name

Pony-tail Protection in Acid Rain Area

15.2. General Characteristics

Acid rain caused by SO₂ can do great harm to pony-tail pines of southern China, and has killed many trees. Pony-tail pine protection in acid rain area can promote the growth of forest and speed up absorbing CO₂ in the atmosphere.

15.3. Cost Information

This technique can reduce the harm suffered by pony-tail pines from acid rain, increase the woods, improve ecological environment, and have great economic benefits. It is pointed out by research that, a great number of pony-tail pines in southern China suffer severely from acid rain. By incomplete statistics, the woods lost for this reason are about 600,000 cubic meters each year, that is the loss of 0.3 billion Yuan. The reduction of the absorption of CO₂ caused by forest loss is great.

15.4. Environmental Effects

This technique can reduce the harm of acid rain to the southern pony-tail pines, increase absorbing resources of CO₂, slow down the pace of greenhouse effect, and devote to improving of global environment. Because the distribution of pony-tail pines in southern China is very extensive, and the pines suffer severely from acid rain, the importing of this technique can not only expand the storing of pony-tail pines, and improve the condition of afforestation, but increase the absorption of CO₂ greatly; thus, the goal of reducing the blowing off CO₂ is attained. It is calculated that the woods lost are 600,000 cubic meter per year, this project (if having been carried out) can absorb 140,000 tones CO₂ a year more than before.

15.5. Market Potential

The distribution of pony-tail pines is extensive in China, and they are the typical kind of coniferous trees in humid area of Chinese eastern subtropical zones. Because pony-tail pines have the advantages of adapting environment easily, growing rapidly, and reforesting naturally or artificially without difficulties. Moreover, the timbers of them are widely used, and with high economic benefit, so they play an important role in exploiting subtropical mountain areas and recovering forest ecosystem. Because the energy structure of China, which is dominated by coal, can not be changed in a short term, and the air pollution tends to be more serious, this technique surely has a good prospects.

15.6. Other Information

- Europe has studied acid rain deeply and thoroughly, so its technique of controlling the harm of acid rain to forest is much advanced and completed. Although Europe have not studied the harm to pony-tail pines specially, we can import and transfer the technique of reducing the harm of acid rain to forest from Europe.
- This technique is planned to be imported by the Ministry of Forestry and carried out by Eco-environment Research Institute of the Ministry of Forestry together with the Forestry Bureau of Guangxi, Sichuan and Guizhou Provinces.